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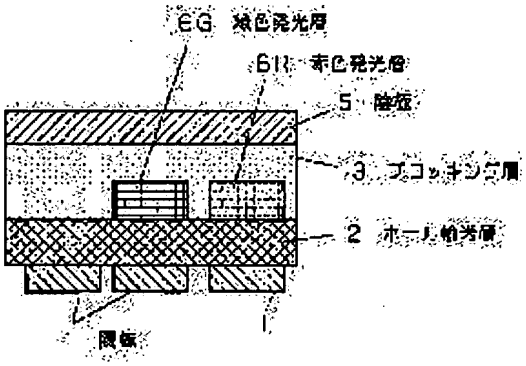
(54) LIGHT-EMITTING ELEMENT AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a light-emitting element having a high color purity and high power efficiency by constituting a phosphorescent material of high efficiency and a fluorescent material of high efficiency in one element.

SOLUTION: A light-emitting element having a high color purity and high power efficiency is realized by having the red color luminous picture element and the green color luminous picture element contain a phosphorescent material, and making the blue color luminous picture element a laminated structure of a hole transport material and a blocking material having a large band gap. Further, the manufacturing process is simplified by forming the hole transport layer, blocking layer or the electron transport layer on the whole surface, thereby, a display device having good reproducibility, low power consumption and high quality picture can be provided.



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CLAIMS

[Claim(s)]
[Claim 1] The light emitting device characterized by having at least one luminescence pixel which has a hole transporting bed and the luminous layer which contains a fluorescence ingredient in the light emitting device which has the luminescence pixel separated for every color of RGB between an anode plate and cathode, and the luminescence pixel which has a luminous layer containing a phosphorescence ingredient.
[Claim 2] The light emitting device characterized by for a green luminescence pixel and a red luminescence pixel being an anode plate, a hole transporting bed, the luminous layer containing a phosphorescence ingredient, a blocking layer, and the light emitting device that consists of cathode one by one in the light emitting device which has a hole transporting bed and the luminescence pixel separated for every color of RGB, and a blue luminescence pixel consisting of an anode plate, a hole transporting bed, a blocking layer, and cathode one by one between an anode plate and cathode.
[Claim 3] The light emitting device according to claim 2 whose band gap of said blocking layer or a hole transporting bed is 3eV or more.
[Claim 4] The light emitting device according to claim 2 or 3 said whose blocking layer is a phenanthroline derivative.
[Claim 5] The light emitting device according to claim 2 or 3 said whose hole transporting bed is a triphenylamine derivative.
[Claim 6] A light emitting device given in any 1 term of claims 2-5 which have an electron transport layer between cathode and a blocking layer.
[Claim 7] The light emitting device characterized by being a hole transporting bed and the luminous layer in which a green luminescence pixel and a red luminescence pixel contain [a blue luminescence pixel] a phosphorescence ingredient in the light emitting device which has the luminescence pixel separated for every color of blue, green, and red, including a fluorescence ingredient, and having a blocking layer between an anode plate and cathode at both the said green luminescence pixel and pixel top of said red luminescence pixel.
[Claim 8] The light emitting device according to claim 7 whose blocking layer is a phenanthroline derivative.
[Claim 9] The light emitting device according to claim 7 or 8 which has an electron transport layer in contact with cathode.
[Claim 10] The manufacture approach of the light emitting device characterized by having the process which forms a hole transporting bed in the whole surface, the process which forms the luminous layer in which a green luminescence pixel and a red luminescence pixel contain a phosphorescence ingredient, and the process which forms a blocking layer in the whole surface.
[Claim 11] The manufacture approach of a light emitting device that the process which forms a hole transporting bed in the whole surface, and a blue luminescence pixel are characterized by a green luminescence pixel and a red luminescence pixel having the process which forms a blocking layer on the process which forms the luminous layer containing a phosphorescence ingredient, said green

luminescence pixel, and both the pixels of said red luminescence pixel, including a fluorescence ingredient.

[Claim 12] The manufacture approach of the light emitting device according to claim 11 which forms a blocking layer simultaneously also between said green luminescence pixel and the pixel of said red luminescence pixel.

[Claim 13] The manufacture approach of the light emitting device according to claim 11 or 12 which forms a blocking layer all over removing the pixel top of a blue luminescence pixel.

[Claim 14] The manufacture approach of a light emitting device given in any 1 term of claims 10-13 which have the process which forms an electron transport layer in the whole surface after the blocking stratification.

[Claim 15] The display device which possesses a current feed zone further in claims 1 and 2 or any 1 term of 7 in addition to the light emitting device of a publication.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the display device used as a luminescence display, a back light for liquid crystal displays, etc.
[0002]
[Description of the Prior Art] An electroluminescence (EL) panel has high visibility, it excels in display capacity, and the high-speed response also has the description of being possible. In recent years, the report was made about the organic light emitting device which makes an organic compound a component (for example, related paper applied physics Letters, 51st volume 913 page 1987 (Applied Physics Letters, 51 and 1987, P.913.).). It is the outstanding fluorescent material with which use the tris (eight quinolinol) aluminum complex (henceforth, Alq) as a luminescent material, and it has a fluorescent material and high luminous efficiency and electronic transport.
[0003] Moreover, in exciton formation, in [a triplet excitation state] statistical theory, since the generation probability is high, the measure is also taken for the phosphorescence ingredient (for example, USP6,097,147). Although transition probability of phosphorescence was originally low because of forbidden transition, transition probability was able to be improved by using the heavy-metal complex which has Ir and Pt in a central metal using an internal heavy atom effect. Furthermore, although exciton diffusion arises and it becomes the factor of degradation since radiation time amount is long when phosphorescence is used as a device, by carrying out the laminating of the blocking layer to the cathode side of a luminous layer, exciton diffusion was controlled and efficient-ization is realized.
[0004]
[Problem(s) to be Solved by the Invention] However, since the phosphorescence produced from a triplet excitation state is lower than the singlet excitation state which emits fluorescence in energy, compared with a fluorescence ingredient, long wavelength-ization of luminescence wavelength produces it. Since it became indispensable especially in a blue ingredient amending [of the chromaticity lowering of color purity is excessive and according to a light filter etc.], a manufacture process not only increases, but the technical problem that loss of effectiveness arose as a component and equipment occurred.
[0005]
[Means for Solving the Problem] Then, by considering a blue luminescence pixel as the laminating configuration of the big hole transport ingredient of a band gap, and a blocking ingredient at a red luminescence pixel and a green luminescence pixel including a phosphorescence ingredient, our color purity is high and we came to realize the light emitting device with low operating voltage. Furthermore, by forming a blocking layer in the whole surface and realizing blue luminescence with a hole transport ingredient or a blocking ingredient, a manufacture process can be simplified, consequently repeatability is good, and it was able to come to offer the display of efficient luminescence.
[0006] The light emitting device characterized by having the luminescence pixel which specifically has the luminous layer which contains at least one luminescence pixel which has a hole transporting bed and the luminous layer which contains a fluorescence ingredient in the light emitting device which has the

luminescence pixel separated for every color in three primary colors, and phosphorescence ingredient between an anode plate and cathode according to invention of claim 1 of this application is offered.
[0007] Between an anode plate and cathode, in a hole transporting bed and the light emitting device which has the luminescence pixel separated for every color in three primary colors, a green luminescence pixel and a red luminescence pixel are an anode plate, a hole transporting bed, the luminous layer containing a phosphorescence ingredient, a blocking layer, and the light emitting device that consists of cathode one by one, and, according to invention of claim 2 of this application, the light emitting device characterized by a blue luminescence pixel consisting of an anode plate, a hole transporting bed, a blocking layer, and cathode one by one is offered.
[0008] Claim 3 of this application presupposes that the band gap of a blocking layer according to claim 2 or a hole transporting bed is 3eV or more.
[0009] Claim 4 of this application presupposes that a blocking layer according to claim 2 or 3 is a phenanthroline derivative.
[0010] Claim 5 of this application presupposes that a hole transporting bed according to claim 2 or 3 is a triphenylamine derivative.
[0011] claim 6 of this application -- claims 2-5 -- suppose that it has an electron transport layer between cathode given in either, and a blocking layer.
[0012] Between an anode plate and cathode, in the light emitting device which has a hole transporting bed and the luminescence pixel separated for every color of blue, green, and red, it is the luminous layer in which a green luminescence pixel and a red luminescence pixel contain a phosphorescence ingredient, and, according to invention of claim 7 of this application, the light emitting device to which a blue luminescence pixel is characterized by having a blocking layer on said green luminescence pixel and both the pixels of said red luminescence pixel, including a fluorescence ingredient is offered.
[0013] Claim 8 of this application presupposes that a blocking layer according to claim 7 is a phenanthroline derivative.
[0014] Claim 9 of this application presupposes that it has an electron transport layer in contact with cathode according to claim 7 or 8.
[0015] In the manufacture approach of a light emitting device of having the process which forms a hole transporting bed between an anode plate and cathode, and the process which forms the luminescence pixel separated for every color according to invention of claim 10 of this application The manufacture approach of the light emitting device characterized by having the process which forms a hole transporting bed in the whole surface, the process which forms the luminous layer in which a green luminescence pixel and a red luminescence pixel contain a phosphorescence ingredient, and the process which forms a blocking layer in the whole surface is offered.
[0016] In the manufacture approach of a light emitting device of having the process which forms a hole transporting bed between an anode plate and cathode, and the process which forms the luminescence pixel separated for every color of blue, green, and red according to invention of claim 11 of this application The process which forms a hole transporting bed in the whole surface, and the process in which a blue luminescence pixel forms the luminous layer in which a green luminescence pixel and a red luminescence pixel contain a phosphorescence ingredient, including a fluorescence ingredient, The manufacture approach of the light emitting device characterized by having the process which forms a blocking layer on said green luminescence pixel and both the pixels of said red luminescence pixel is offered.
[0017] Claim 12 of this application presupposes that a blocking layer according to claim 11 is simultaneously formed also between said green luminescence pixel and the pixel of said red luminescence pixel.
[0018] Claim 13 of this application presupposes that a blocking layer according to claim 11 or 12 is formed all over removing the pixel top of a blue luminescence pixel.
[0019] claim 14 of this application -- claims 10-13 -- suppose that an electron transport layer is formed in the whole surface after the blocking stratification given in either.
[0020] In the display which possesses a means to generate a picture signal, the driving means which

generates the current according to said picture signal, and a display means to emit light according to said current according to invention of claim 15 of this application Said display means is the light emitting device which has the luminescence pixel separated for every color in three primary colors, and the display characterized by having at least one luminescence pixel which has a luminous layer containing a fluorescence ingredient, and the luminescence pixel which has a luminous layer containing a phosphorescence ingredient is offered.

[0021] In the display which possesses a means to generate a picture signal, the driving means which generates the current according to said picture signal, and a display means to emit light according to said current according to invention of claim 16 of this application The green luminescence pixel and red luminescence pixel of said display means one by one An anode plate, a hole transporting bed, It is the luminous layer containing a phosphorescence ingredient, a blocking layer, and the light emitting device that consists of cathode, and the display characterized by having the light emitting device which a blue luminescence pixel becomes from an anode plate, a hole transporting bed, a blocking layer, and cathode one by one is offered.

[0022] A means to generate a picture signal according to invention of claim 17 of this application, and the driving means which generates the current according to said picture signal, In the display possessing a display means by which the luminescence pixel separated for every color of blue, green, and red according to said current emits light The display with which the blue luminescence pixel of said display means is characterized by for a green luminescence pixel and a red luminescence pixel being the luminous layers containing a phosphorescence ingredient, and having a blocking layer on said green luminescence pixel and both the pixels of said red luminescence pixel, including a fluorescence ingredient is offered.

[0023]

[Embodiment of the Invention] The gestalt of operation of this invention is explained below.

[0024] If the band gap of luminescent material is 3eV or more, it will be guessed that luminescence wavelength becomes shorter than 370nm, and the luminescent color will serve as a blue field. The light emitting device of the gestalt of this operation has realized blue luminescence by the laminating configuration of a hole transporting bed and a blocking layer by setting the band gap of the hole transporting bed of a blue luminescence pixel, or a blocking layer to 3eV or more. The blocking layer described here has the effectiveness which blocks a hole, and has a bigger value than the ionization potential of each color luminescent material. A hole transport ingredient may emit light, a blocking ingredient may emit light, and, as for blue luminescence at this time, both a hole transport ingredient and a blocking ingredient may emit light. As a desirable configuration for a blue luminescence picture element part, it is an anode plate / hole transporting bed / blocking layer / electron transport layer / cathode, and when a blocking layer achieves the function of an electron transport layer, it can consider as an anode plate / hole transporting bed / blocking layer / cathode. By including a phosphorescence ingredient in a luminous layer, the amount of green luminescence pixel and red luminescence picture element part need to carry out the laminating of the blocking layer to the cathode side of a luminous layer. Therefore, when a blocking layer besides an anode plate / hole transporting bed / luminous layer / blocking layer / electron transport layer / cathode, and an anode plate / luminous layer / blocking layer / electron transport layer / cathode achieves the function of an electron transport layer as a configuration, it can consider as an anode plate / hole transporting bed / luminous layer / blocking layer / cathode, and an anode plate / luminous layer / blocking layer / cathode.

[0025] What is shown in drawing 1 is mentioned as an example of the gestalt of this operation.

[0026] Since blue, green, the hole transporting bed 2 used for each red pixel, and a blocking layer can be formed in the whole surface by considering as a common ingredient configuration, they can simplify a process and can produce the light emitting device of the engine performance stabilized with sufficient repeatability.

[0027] As a gestalt of other operations in this invention, there is a method of using a blue fluorescence ingredient for a blue luminescence pixel. As a desirable configuration for a blue luminescence picture element part at this time, it is an anode plate / hole transporting bed / luminous layer / electron transport

layer / cathode, and when a blocking layer achieves the function of an electron transport layer, the laminating of green and the blocking layer used for a red luminescence pixel can be carried out, and it can consider as an anode plate / hole transporting bed / luminous layer / blocking layer / cathode.
[0028] What is shown in drawing 2 is mentioned as an example of the gestalt of this operation.
[0029] By considering as a common ingredient configuration, blue, green, the hole transporting bed 2 used for each red pixel, and an electron transport layer 4 can simplify a process like an above-mentioned case from the ability to form in the whole surface, and can produce the light emitting device of the engine performance stabilized with sufficient repeatability.
[0030] The light emitting device of the gestalt of this operation can use an anode plate, cathode, above-mentioned each class, etc. and a laminating configuration on a substrate as a basic configuration.
[0031] A substrate just supports the light emitting device which carried out the laminating of the thin film mentioned above. In taking out the light produced within above-mentioned each class from a substrate side, it uses the glass of Corning 1737 grade, or the resin film of polyester and others that what is necessary is just transparence thru/or a translucent ingredient. Moreover, especially in taking out from a substrate and an opposite hand, it does not ask construction material and a class.
[0032] It is desirable to use the ITO (indium stannic acid ghost) film for the anode plate as a hole-injection electrode of the light emitting device of the gestalt of this operation. To others, tin oxide, nickel, Au, Pt, Pd, etc. are mentioned. It is the object for which the ITO film raises the transparency or resistivity is reduced, and the membrane formation approaches, such as a spatter, EB vacuum evaporationo, and ion plating, are adopted. Moreover, by the light emitting device, although thickness is determined from the sheet resistance and light permeability which are needed, since actuation current density is comparatively high, in order to make sheet resistance small, it is used by the thickness of 100nm or more in many cases. Alloys of the low metal and the metal with it of an electron injection obstruction with a low work function, such as a MgAg alloy or an AlLi alloy which Tang and others proposed, are used for the cathode as an electronic notes telegram pole in many cases. [a large work function and] [comparatively stable] Moreover, the low metal of a work function is formed to an organic layer side, the laminating of the big metal of a work function may be carried out thickly, and a laminating electrode like Li/aluminum and LiF/aluminum can be used in order to protect this low work function metal. To formation of these cathode, vacuum deposition and a spatter are desirable. In order to take out light from a substrate and an opposite hand, it is necessary to make a cathode side transparently or translucent.
[0033] Therefore, thin films, such as a thin film of the MgAg alloy which Tang and others besides the thin film of the above-mentioned ITO film, tin oxide, nickel, Au and Pt, and Pd film proposed, and an AgPdCu alloy, can be used. Since there is a possibility that an organic layer may receive breakage when a light emitting device consists of organic materials, it is desirable to prepare buffer layers, such as phthalocyanine derivatives, such as a dilithium phthalocyanine, and a PIRAZA ball derivative, and it is still better for a work function to make the low low metal of an electron injection obstruction, for example, Li, Na, K, Mg, calcium, etc., contain in a buffer layer. Moreover, transparence or when it is made translucent, you may have a reflecting layer for cathode in the anode plate of a light emitting device. As an ingredient which forms a reflecting layer, a metal is desirable, and metals with it, such as aluminum, Ag, nickel, Cu, and Bi, are especially desirable. [a large work function and] [comparatively stable]
[0034] The derivative which has the triphenylamine which is excellent in hole transport ability, and has a large band gap 3eV or more as an ingredient which constitutes a hole transporting bed as a basic frame is desirable. For example, a tetra-phenyl benzidine compound, a triphenylamine trimer, and a benzidine dimer are mentioned. Moreover, a triphenyl diamine derivative or MTPD (N and N'-diphenyl N, N'-screw (3-methylphenyl) - 1 and 1'-biphenyl - 4 and 4'-diamine, common name TPD) is sufficient. Especially, a triphenylamine tetramer is desirable.
[0035] As an ingredient which constitutes an electron transport layer, tris (8-quinolinolato) aluminum (henceforth, Alq) is desirable. Metal complexes, such as tris (4-methyl-8-quinolinolato) aluminum, a 3-(2'-benzothiazolyl)-7-diethylamino coumarin, etc. are mentioned as other examples. As for the thickness

of an electron transport layer, it is desirable to be referred to as 10-1000nm.
[0036] As an ingredient which constitutes the luminous layer of the gestalt of this operation, they are 2, 3, 7, 8, 12, 13, 17, and 18-OKUTA ethyl-21H23H-porphin as tris (2-phenyl pyridine) iridium and a red phosphorescence ingredient as a green phosphorescence ingredient. Like platinum (II), it is desirable to use the heavy-metal complex of the phosphorescence luminescence. By using the complex which utilization of luminescence from the high triplet exciton of a generation probability is effective for efficient-izing, and has heavy metal as a central metal as a luminescent material, whenever [prohibition] can be eased and transition probability can be raised. As a blue fluorescence luminescent material, the charge of an admixture of a 4 and 4'-bis(2 and 2-diphenyl vinyl) biphenyl, 4, 4 and 8, 8-tetrakis (PIRAZA ball-1-IRU) PIRAZA ball, and a phenyl styryl pyrene etc. is desirable. Application of the fluorescence ingredient to a blue luminescence pixel can prevent long wavelength-ization of the luminescence wavelength by triplet utilization of phosphorescence, and can raise color purity. Furthermore, since all the thickness of a blue luminescence pixel can be reduced by considering as the laminating of a hole transporting bed and a blocking layer, or the laminating of a hole transporting bed and a luminous layer, it can fall operating voltage, and by this, it can reduce the load to a component and it not only can reduce power consumption, but can realize reinforcement.
[0037] As an ingredient which constitutes the blocking layer of the gestalt of this operation, phenanthroline derivatives, such as 2, the 9-dimethyl -4, 7-diphenyl -1, 10-phenanthroline, 4, 7-diphenyl -1, and 10-phenanthroline, are desirable. Since these ingredients are excellent in electronic transport ability, the function as an electron transport layer can also have them. Furthermore, since it has a large band gap 3eV or more, light can be emitted for this ingredient itself blue.
[0038] About each class of an above-mentioned hole transporting bed, an electron transport layer, a luminous layer, and a blocking layer, it is desirable to form the homogeneous film of an amorphous condition, and membrane formation by the vacuum deposition method is desirable. Furthermore, an improvement of properties, such as lowering of operating voltage, efficient-izing, and reinforcement, can be aimed at by preventing an impurity adhering to the interface between each class by forming each class continuously in a vacuum. moreover, although it is desirable that carry out temperature control of each boat into which the compound was put, and it carries out vapor codeposition according to an individual when in forming these each class with a vacuum deposition method it is further alike and makes two or more compounds contain, what was mixed beforehand may be vapor-deposited. as the further other membrane formation approaches -- the solution applying method and Langmuir Blodgett (LB) -- law etc. can also be used. It is good also as a configuration which distributes each compound in matrix matter, such as a polymer, by the solution applying method.
[0039] By the display of the gestalt of this operation arranging the light emitting device of this invention in on a matrix, and being able to carry out the laminating of it, being able to use it on the substrate in which TFT was carried, and using the above-mentioned light emitting device, the luminous efficiency of each color is high and a high definition display can be offered from luminescence of high color purity being obtained.
[0040] In this example, although described about the case where a blue luminescence pixel is a fluorescence ingredient, it is not limited to the gestalt of the above-mentioned implementation, but can apply to other operation gestalten in which a green luminescence pixel or a red luminescence pixel contains a fluorescence ingredient based on the technical thought of this invention for the improvement in color purity, or operating voltage reduction.
[0041]
[Effect of the Invention] As explained above, according to the light emitting device of this invention, a thing light emitting device with high power efficiency is realizable with high color purity by constituting an efficient phosphorescence ingredient and an efficient fluorescence ingredient in the same component. Since all the thickness of a blue luminescence pixel can be reduced by making a blue luminescence pixel into the laminating of a hole transporting bed and a blocking layer, or the laminating of a hole transporting bed and a luminous layer especially, it can fall operating voltage, and by this, it can reduce the load to a component and it not only can reduce power consumption, but can realize reinforcement.

According to the manufacture approach of the light emitting device of this invention, since blue, green, the hole transporting bed used for each red pixel, a blocking layer, and an electron transport layer can be formed in the whole surface by considering as a common ingredient configuration, they can simplify a process and can produce the light emitting device of the engine performance stabilized with sufficient repeatability. While according to the display of this invention a high-definition image is stabilized and is obtained by having the light emitting device of this invention, it is a low power and the high-reliability over a long period of time is secured.

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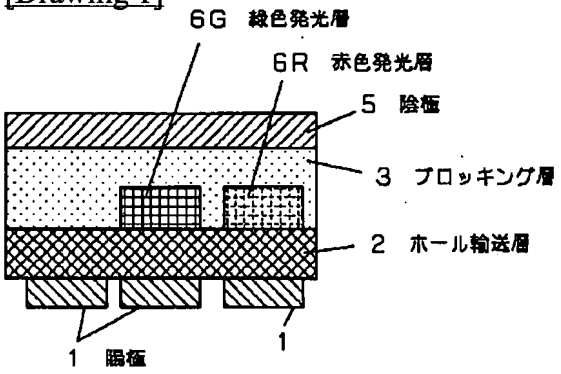
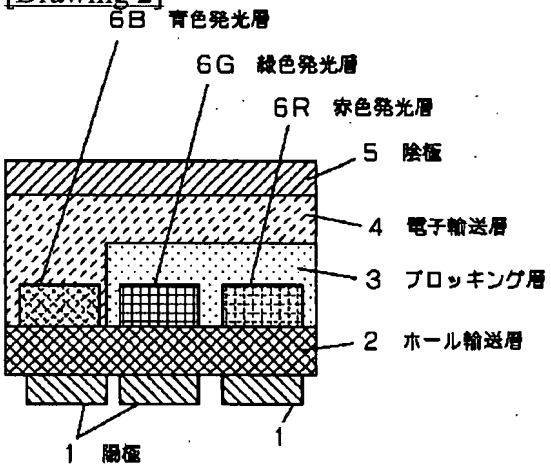
DRAWINGS

[Drawing 1]



[Drawing 2]



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] One sectional view of this invention light emitting device
[Drawing 2] Other one sectional views of this invention light emitting device
[Description of Notations]
1 Anode Plate
2 Hole Transporting Bed
3 Blocking Layer
4 Electron Transport Layer
5 Cathode
6B Blue luminous layer
6R Red luminous layer
6G Green luminous layer

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